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TAR AND NICOTINE RETRIEVAL FROM FIFTY-SIX BRANDS OF CIGARETTES

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Tar and nicotine yields of 56 brands of cigarettes are determined. Tar yields range from a low of about 8 mg per cigarette to a high of about 43 mg per cigarette. Nicotine yields, which closely correlate with tar yields in most cases, range from about 0.3 to 2.6 mg per cigarette. There are substantial differences among cigarettes of the same general type. Among cigarettes without filters tar yield depends chiefly on the length of the cigarette. Filter cigarettes show the greatest variability in tar yield, ranging from 8 to 42 mg per cigarette. Among cigarettes with filters tar yield depends on the length of the cigarette and the weight of the filter, longer cigarettes and light-weight filters being associated with higher tar yields. It seems clear that manufacturers are able to produce cigarettes with almost any yield of tar and nicotine from very low to very high. This potentiality is important in the control of diseases caused by cigarette smoking.

THE BIOLOGICAL ACTIVITY OF TOBACCO SMOKE has been demonstrated extensively in human beings and experimental animals.[1-8] The ability of tobacco smoke to induce cancer in human beings is paralleled by its ability to provoke various kinds of malignant lesions in several animal species.[1-9] In common with most carcinogens, tobacco smoke shows a dose-dependent relationship that can be plotted from both human and animal data.[1, 6, 7, 9, 21]

The importance of keeping exposure of the bronchial system to tobacco smoke to a minimum until such a time that it is possible to remove the offending noxious materials is apparent to all sincere students of this major public health problem. Practical techniques include the following:

1. Cessation of deep inhalation, either by voluntary effort or by changing from cigarettes to pipes and cigars, which tend to discourage deep inhalation;

2. Alteration of the tobacco in cigarettes so that the resulting effects on the pH or other characteristics of the smoke similarly discourage deep inhalation;

3. Smoking fewer cigarettes;

4. Smoking less of each cigarette;

5. Using filters that appreciably reduce the quantity of smoke particulate that reaches the tissues.

This paper summarizes the relative amounts of total particulate matter (i.e., "tar") and total alkaloids (i.e., "nicotine") recovered from the mainstream smoke of commercial cigarettes of different lengths and compositions, with and without filters. We are well aware that modifications in the protocol can result in somewhat different yields of tar and nicotine. Despite such reservations, however, the data obtained are useful in comparing the potential biological effects of different kinds of cigarettes.

METHODS AND MATERIALS

Cigarettes of 56 brands were purchased, mostly from a single local retail outlet. The gross physical characteristics of the cigarettes are summarized in Table 1. Routinely, cigarettes were removed from packs and stored at room temperature and 60 ± 2% relative humidity for 48 hours. On the day that cigarettes were smoked, they were selected to fall within prescribed ranges for weight (±5 mg) and resistance to air flow (± 0.25 inches of water at a flow rate of 17.5 ml/sec). Immediately after selection, each cigarette was care-

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cigarettes. The increase in tar yield illustrates the detrimental effect of allowing a greater number of puffs per cigarette and thus a greater opportunity for exposure to tar during the smoking of a specified number of cigarettes. This factor is particularly evident on comparing the average number of puffs per cigarette when the cigarettes are listed in order of increasing tar yield (Table 1). A second difference reflected in tar yields is filter design. As the weight of the filter increased, the tar yield per puff decreased ($r = -0.38$; $P<0.05$). For example, Marvel had a filter weighing 20 mg and gave 0.9 mg per puff whereas the high-tar Pall Mall had a filter weighing only 15 mg and gave 3.1 mg per puff. Filter effectiveness also can be correlated with the air resistance of the entire cigarette (Table 1).

Many brands of filter cigarettes include traces to substantial amounts of charcoal in their filters. In this study, charcoal in cigarette filters had no discernible effect on tar or nicotine recovery. Such a result is hardly surprising, however, since the charcoal is usually intended for selective removal of gaseous constituents of the smoke and the Cambridge filter is not designed to collect appreciable quantities of gases.

Problems in switching! The data of the present study are substantially important from the standpoint of public health. A survey of members of the population of Buffalo aged 18 and older indicates that about 60% of all cigarette smokers want to give up smoking.[11] It is well known that many smokers find it impossible to break the habit.[15] A large number of such smokers are interested in shifting to brands with low tar and nicotine contents. Changes in this direction offer appreciable public health gains since the number of cigarettes smoked each day is one of the most stable characteristics of the cigarette habit.[7]

The present study indicates that there is ample range of choice, even among cigarettes of the same type, to permit most smokers to shift to brands with lower yields of tar and nicotine. Unfortunately, there is evidence that cigarettes of very high tar and nicotine outputs also are being produced. A trend toward extra-long cigarettes seems to be developing, and the public health implications of this trend are highly disturbing. A smoker who switches from one of the medium-tar filter cigarettes to Pall Mall filters or Benson & Hedges 100 immediately doubles his exposure to tar and nicotine, if, as is likely, he continues to smoke the same number of cigarettes and to smoke them to approximately the same butt length. The smoker may be unaware of his greatly increased health hazard since he may suppose that he is being protected by the filter.

Timeliness of analyses: Cigarette manufacture is a variable process, even under the best of controls. The tobacco leaf provided in commerce is a product of its environment, both natural and artificial (i.e., fertilizer, suckering agents, insecticides, irrigation, etc.). Furthermore, manufacturing processes have undergone repeated changes over the years.

It now seems clear that manufacturers are able to produce cigarettes with almost any yield of tar and nicotine from very low to very high. The wide variety of filters available is an obvious tool for this purpose. Unfortunately, not all filters are effective. The width of cut in the leaf is also important in determining tar and nicotine yield.[20] Reconstituted tobacco sheet offers still more opportunity for engineering cigarettes. This material is becoming more common in cigarettes and in 1964 it accounted for about 15% of the total cigarette tobacco produced in the United States.[12] Such factors show that analyses for tar and nicotine must be carried out frequently if they are to offer an accurate description of cigarettes currently available. They also show that the industry does have the capability for manufacturing less dangerous cigarettes.

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